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Ms. Stacey Froelich
South Dakota Department
of Environment and Natural Resources
Air Quality Program
523 East Capitol
Pierre, SD 57501

RE: Response to Comments on the PSD Permit Application – BACT Analysis
Basin Electric NextGen Project

Dear Ms. Froelich:

Basin Electric Power Cooperative is responding to your review and comment regarding the PSD permit application for the NextGen project, proposed for a site near Selby, SD. On December 2, 2008, we held a joint conference call regarding the installation of a wet electrostatic precipitator (WESP) on the emissions of the main boiler and the downstream fertilizer plant. Upon further discussion Basin Electric has agreed to provide a formal BACT analysis for the installation of the WESP on the main stack particulate matter emissions. A copy of that BACT analysis is attached.

As you review the responses, both Basin Electric and our consultant AECOM Environment (formerly ENSR) are available to provide responses to questions, and are anxious to expedite the permit application review. Please call Cris Miller (701-355-5635) or Bruce Macdonald at AECOM (970-530-3500) if you have any immediate questions on this response.

We look forward to continuing to work with you and your colleagues in review of this application.

Sincerely,

Cris Miller

Cris Miller
Sr. Environmental Project Administrator

/gmj
Enclosures
cc: Bruce Macdonald / AECOM
D. Randall / Burns & McDonnell

Attachment A
Basin Electric NextGen Project
BACT Analysis for Wet Electrostatic Precipitator

During the initial evaluation of the NextGen BACT, the State of South Dakota Department of Environment and Natural Resources (SDDENR) queried Basin Electric regarding why the wet electrostatic precipitator (WESP) was included as an integral part of the proposed ammonia scrubber. The SDDENR noted it may be appropriate to list the WESP as a separate BACT technology because the ammonia scrubber could be a source of particulate emissions. While Basin Electric believes the original evaluation was appropriate to include the WESP as an integral part of the ammonia scrubbing system, Basin Electric has agreed to evaluate the addition of a WESP separately to determine if the technology should be listed as BACT for any pollutant.

A.1 Evaluation of a Wet Electrostatic Precipitator for BACT

A wet FGD system based on the limestone or lime process downstream of a fabric filter typically will not increase particulate emissions and may slightly reduce particulate emissions. The wet ammonia scrubbing process, proposed as BACT for NextGen, will not have the same expected particulate emissions. An ammonia scrubber will increase particulate matter above the expected inlet PM rate. Based on a vendor estimate, the filterable emission rate in the flue gases ahead of the wet electrostatic precipitator (WESP) is approximately 0.035 lb/MMBtu with the scrubber expected to be the origin of the majority of these emissions. If this source were uncontrolled, the NextGen scrubber would produce more than 900 tons of PM emissions per year. In the original BACT evaluation, a WESP was included as an integral part of the scrubber.

The following is an evaluation of a WESP as BACT for the control of the primary pollutants that a WESP is expected to reduce (H_2SO_4, PM and condensable particulate matter, or CPM). Evaluating a WESP on a total tons of pollutants reduced is a conservative approach that provides the most favorable evaluation for a WESP.

A.1.1 STEP 1. Identify Potential Control Technologies.

A fabric filter baghouse (FF) was selected as the primary filterable emission control technologies for PM emissions from the coal-fired boiler. The use of a fabric filter, ammonia scrubber and low sulfur fuel was selected as the primary emission control technologies for H_2SO_4. No specific control technology was selected for the control of CPM as there is no control technology that is known to specifically reduce pollutants that comprise CPM, that has not already been addressed under other sections of the BACT review. The following technologies are evaluated as the baseline controls prior to the addition of a WESP on the NextGen facility.

Baseline Technologies

- Fabric Filter Baghouse (filterable, baseline)
- Ammonia scrubber (condensable, baseline)
- Low sulfur fuel (H_2SO_4, baseline)

The following technologies are identified as potential control technologies to further reduce emissions beyond the baseline technologies.

Post-Combustion

- Mist Eliminators (filterable)
- Wet Electrostatic Precipitator (filterable + H_2SO_4)

A.1.2 STEP 2. Identify Technically Feasible Control Technologies.

To accurately identify the technically feasible particulate matter control technologies, each potential control technology mentioned in the above section will be analyzed and discussed in this section.

A.1.2.1 Wet Electrostatic Precipitator (WESP)

A WESP is a PM control technology that utilizes electrical charges to attract particulate matter present in the gas stream. An ESP consists of negatively charged discharge electrodes and positively charged collection plates or tubes. The negatively charged electrodes create a corona of electrical charges transmitting a negative charge to the particulate matter in the gas stream. The negatively charged particulate matter is then attracted to the ESP's positively charged collection surface. Particulate matter accumulates on the collection plate or tube until the surface is washed, causing the PM to fall into collection devices below the plates.

A WESP operates in saturated flue gas conditions, where the flue gas is below the dew point of many acid gases and other condensable particulate materials. It controls both solid particles and small droplets that are formed in the wet scrubber system. This is typically downstream of a wet FGD system. WESP is a feasible H_2SO_4 control technology that has been installed on units burning high-sulfur bituminous coal. A WESP is not a primary PM control technology, however WESP is a feasible control technology for reducing PM created in the scrubber and H_2SO_4 emissions.

A.1.2.2 Mist Eliminators (ME)

Mist eliminators are designed to collect and remove small droplets that may include dissolved or suspended solids in the flue gas. They reduce the filterable PM_{10} emissions from a scrubber by utilizing chevron vanes to force the exhaust stream to make directional changes. As the gas exhaust stream changes directions, the liquid droplets impact the vanes, removing the droplets and thereby reducing the filterable PM_{10} emissions from the scrubber. Mist eliminators work by forcing droplets to impact the mist eliminators vanes and drain back into the scrubber. Particulate that is extremely fine such as H_2SO_4 mist or other aerosols do not have sufficient momentum to be carried into the vanes and instead pass through the ME without being collected. Therefore mist eliminators provide limited removal of such fine particulate matter. An ammonia scrubber will produce added filterable aerosols within the scrubber due to gas phase reactions between ammonia and SO_2 or SO_3. Guaranteed carryover (emission) rates from mist eliminators typically range from 0.010-0.015 grains of droplet carry over per dry standard cubic foot of flue gas. These vendor guarantees typically exclude droplets smaller than 40 microns in size. The actual PM emission rate will depend both on the extent of the carryover of droplets and the PM concentration in the water droplets, as well as the contribution of droplets smaller than 40 microns which are not included in the vendors' droplet emission guarantee. Based on the above range of carryover guarantees the potential PM emissions due only to droplet carry over from the NextGen scrubber could result in PM emission rates of 0.012-0.017 lb/MMBtu. This range includes rates that are greater than the PM NSPS rate of 0.015

lb/MMBtu and does not include filterable aerosols [which would be smaller than 40 microns] that are expected to form in an ammonia scrubber. The estimated range of PM emission rates from a mist eliminator accounts for only the solids that are contained in the liquid carryover from the scrubber because most solid aerosol emission are expected to be carried through the mist eliminator. Due to the small size of these aerosols, a significant fraction of the aerosol emissions does not impact the mist eliminator vanes. The low collection efficiency of the mist eliminator for these small aerosols is due to the limited momentum of the aerosol particles. As the mist eliminator vanes turn the gas, momentum of a 'heavy' water droplet carries water droplets in a different direction than the gas and impacts the droplet on the vanes where it is collected. The momentum of aerosol particles, however, is insignificant compared to the forces of the flue gas and thus they are carried through the mist eliminator with the flue gas without being collected.

Design configurations of mist eliminators include herringbone, blade, wave form, and cellular. Mist eliminators are a technically feasible, demonstrated and available control technology for PM_{10} emissions from FGD systems and will be retained for further BACT analysis for PM_{10} emission control.

A.1.3 STEP 3. Rank the Control Technologies.

Table WESP-1 ranks the technically feasible control technologies that are being considered further for filterable particulate matter control.

Table WESP-1

Summary of Filterable and Condensable Particulate Matter Control Technologies

Rank	Control Technology[A]	Recent Filterable Permit Rates	Recent Condensable + Filterable Permit Rates	Emission Limit Evaluated PM / All PM (lb/MMBtu)
1	FF + FGD + WESP[B]	0.012-0.015	0.028-0.035	0 / 0.0037
2	FF + FGD + Mist Eliminator	0.012-0.015	0.018-0.055	0.012[C] / 0.0309
3	FF + FGD	0.012-0.015	0.018-0.033	0.035 / 0.0539

[A] Coal selection is included with all of the listed control technology combinations.
[B] Assumes 100% removal of PM and non-H_2SO_4 CPM emissions.
[C] Ignores potential filterable emissions due to scrubber related aerosols.

In order to calculate cost effectiveness, this evaluation assumes 100 percent removal rate of CPM and PM (excluding H_2SO_4) due to the WESP. This assumption is conservative as it provides removal of the greatest number of tons, and therefore the lowest dollars per ton feasible. This evaluation also assumes the lower range of filterable emissions from the mist eliminators is achieved, no filterable aerosols are emitted and no removal of H_2SO_4 and CPM is achieved in the mist eliminators.

A.1.4 STEP 4. Evaluate the Most Effective Controls.

As previously noted the FF and FGD are determined to be BACT in the PM, SO_2 and H_2SO_4 evaluation. Because these technologies were determined to be BACT for other pollutants, this evaluation includes these technologies in its review as a baseline technology.

A.1.4.1 Top Ranked Control Technology – WESP

The most effective combination of technologies is fabric filter and wet FGD upstream of a WESP. Table WESP-2 lists the emission rates upstream and downstream of the WESP, along with an evaluated removal rate.

Table WESP-2
Theoretical Impact of a WESP at NextGen

Pollutant	Pre-Control (lb/MMBtu)	Removed by Control[A] (lb/MMBtu)	Post - Control (lb/MMBtu)	Uncontrolled tpy	Emissions Reduced tpy
PM (filterable)[B, C]	0.035	0.035	0.0000	1,074.6	1,074.6
PM (condensable- H_2SO_4)[B, D]	0.0143	0.0143	0.0000	438.3	438.3
H_2SO_4[F]	0.0046	0.0009	0.0037	142.0	28.4
Total	0.0539	0.0502	0.0037	1,654.9	1,541.3
Total Removal Rate:		93.1%			

[A] Beyond feasible removal rates have been assumed for PM and CPM to provide the most conservative evaluation.
[B] Assumes that WESP will remove 100% of all PM emissions as a conservative assumption.
[C] Based on vendor estimates of PM rates prior to the WESP.
[D] This evaluation assumes that non-H_2SO_4 CPM emissions are approximately triple the H_2SO_4 emissions.
[E] Assumes that WESP will remove 100% of all non-H_2SO_4 condensable emissions as a conservative assumption.
[F] Based on H_2SO_4 BACT.

The PM and non-H_2SO_4 CPM emission limits indicated in Table WESP-2 are impractical emissions that are utilized for a conservative evaluation of particulate removal in a WESP. WESP vendors do not supply removal guarantees for filterable PM or for filterable plus condensable PM at the emission limits listed in Table WESP-2.

Environmental Impacts
In a WESP application the cooler temperatures after the wet FGD may condense some remaining HAPs into vapor or particulate matter that can be collected. A WESP system will produce a waste water stream that will require treatment. Portions of this stream could be sent to the FGD system as make up depending on the water balance in the FGD system.

Energy Impacts
The power required to collect particulate matter in the WESP and the pressure loss across the WESP are the main operating costs of the WESP system. For the NextGen boiler, the power consumption of a WESP is estimated to be approximately 0.5 percent of each unit's generating capacity. At an annual capacity factor of 85 percent, this would be an energy penalty of approximately 28,000 MW-hr per year, or enough electric energy for the annual power requirements of about 2,300 homes. This energy impact is taken into consideration in the economic impact review.

Economic Impacts
Economic feasibility is normally evaluated according to the average and incremental cost effectiveness of the control option. Average cost effectiveness is expressed as the cost per ton of pollutant reduced.

Average Cost Effectiveness.
Average cost effectiveness is calculated as:

$$C_{ave} = \frac{\text{Control Option Annualized Cost}}{\text{Baseline Emissions Rate} - \text{Control Option Emission Rate}}$$

where, C_{ave} = Average cost effectiveness, $ per ton of pollutant controlled

Table WESP-3 is a detailed economic evaluation of all control options beyond the just the fabric filter and wet FGD combination alone.

Table WESP-3

Summary of the Economic Impact Analysis for PM and CPM Control Technologies

CONTROL ALTERNATIVE	Uncontrolled Emission Rate	CONTROL EFFICIENCY	CONTROLLED EMISSION RATE		REDUCTION, tons per year		CONTROL TECHNOLOGY COSTS ($1,000)[A]			COST EFFECTIVENESS, $ per ton
	lb/MMBtu		lb/ MMBtu	tons/ year	Average	Incre-mental	Capital	Annual O&M	Total Annual	Average
FF, Wet FGD & WESP	0.0539	93.1	0.0037[B]	114	1,541	835	16,800	4,055	5,611	3,641
FF, Wet FGD & Mist Eliminator	0.0539	42.7	0.0309	949	706	706	250	20	44	62
FF, & Wet FGD (Baseline)[C]	0.0539		0.0539	1655						

Footnotes

A. Analysis performed using standard techniques following USEPA guidelines and policies. Numbers based on internal estimates.
B. Beyond feasible removal rates have been assumed to provide the most conservative evaluation.
C. No mist eliminator is included in the baseline.

Assumptions

Life, years	30	Insurance	0.4%
Interest Rate, %	7	O &M Levelization Factor	1.4134
Capital Recovery Factor	0.08059	Inflation, %	3.0

The addition of a WESP downstream of the wet FGD system will reduce baseline emissions approximately 1,541 tons per year. On an incremental basis, the WESP will reduce emissions by 835 tons per year compared to the next best option and by 1,541 tons per year from the baseline. The use of the WESP system would require an additional capital cost of $16.8 million[1] and an additional annual operating and maintenance cost of $4.1 million, resulting in an annual total cost of $5.61 million, the average control cost effectiveness is $3,641 per ton.

Conclusion
Based on the above analysis, the use of a WESP system in combination with the baseline controls can theoretically reduce total pollutant emission up to 835 tons per year more than the next most effective control. The WESP system may increase the amount of waste water that requires treatment and the WESP system will increase auxiliary power consumption approximately 0.5 percent primarily due to additional power requirements for collection. Considering that very conservative assumptions were made regarding the effectiveness of the WESP in regard to the removal of all pollutants and the resulting average cost of control is greater than $3,600 per ton of all pollutants removed (a majority of which is filterable particulate matter), this evaluation considers the cost of a WESP to be excessive.

This review has found unacceptable economic impacts in the use of a WESP while evaluating the technology using very conservative assumptions regarding the performance of the WESP. Based on these findings, this analysis concludes the use of WESP systems for the NextGen boilers does not represent the best available control technology. However, due to the expectations that PM emissions could be in excess of the PM NSPS limit if the WESP is not utilized and that at least one vendor will not sell the ammonia scrubber without a WESP, a WESP shall be installed on the NextGen wet FGD. Therefore, no further evaluation is necessary.

A.1.5 STEP 5. Final Determination.

The use of a WESP is considered excessively expensive to be determined as BACT for PM control. However it is a necessary control technology for PM emissions due to the unique characteristics of an ammonia scrubber. The ammonia wet FGD is a fairly new and innovative technology for controlling SO_2 emissions from electric generating units, and the cobenefit emissions control for PM, CPM and H_2SO_4 is therefore not as well defined. The previously proposed PM, PM+CPM and H_2SO_4 emission limits included the use of an integrated WESP system and are considered appropriate.

[1] Capital and O&M cost of WESP are based on vendor information plus 20% contingency and are considered to be conservatively low.